

Thermal Expansion and Thermal Conductivity of Rare Earth Silicates

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Abstract:

Rare earth silicates are considered promising candidate materials for environmental barrier coatings applications at elevated temperature for ceramic matrix composites. High temperature thermophysical properties are of great importance for coating system design and development. In this study, the thermal expansion and thermal conductivity of hot-pressed rare earth silicate materials were characterized at temperatures up to 1400°C. The effects of specimen porosity, composition and microstructure on the properties were also investigated. The materials processing and testing issues affecting the measurements will also be discussed.



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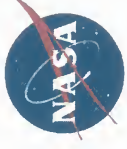
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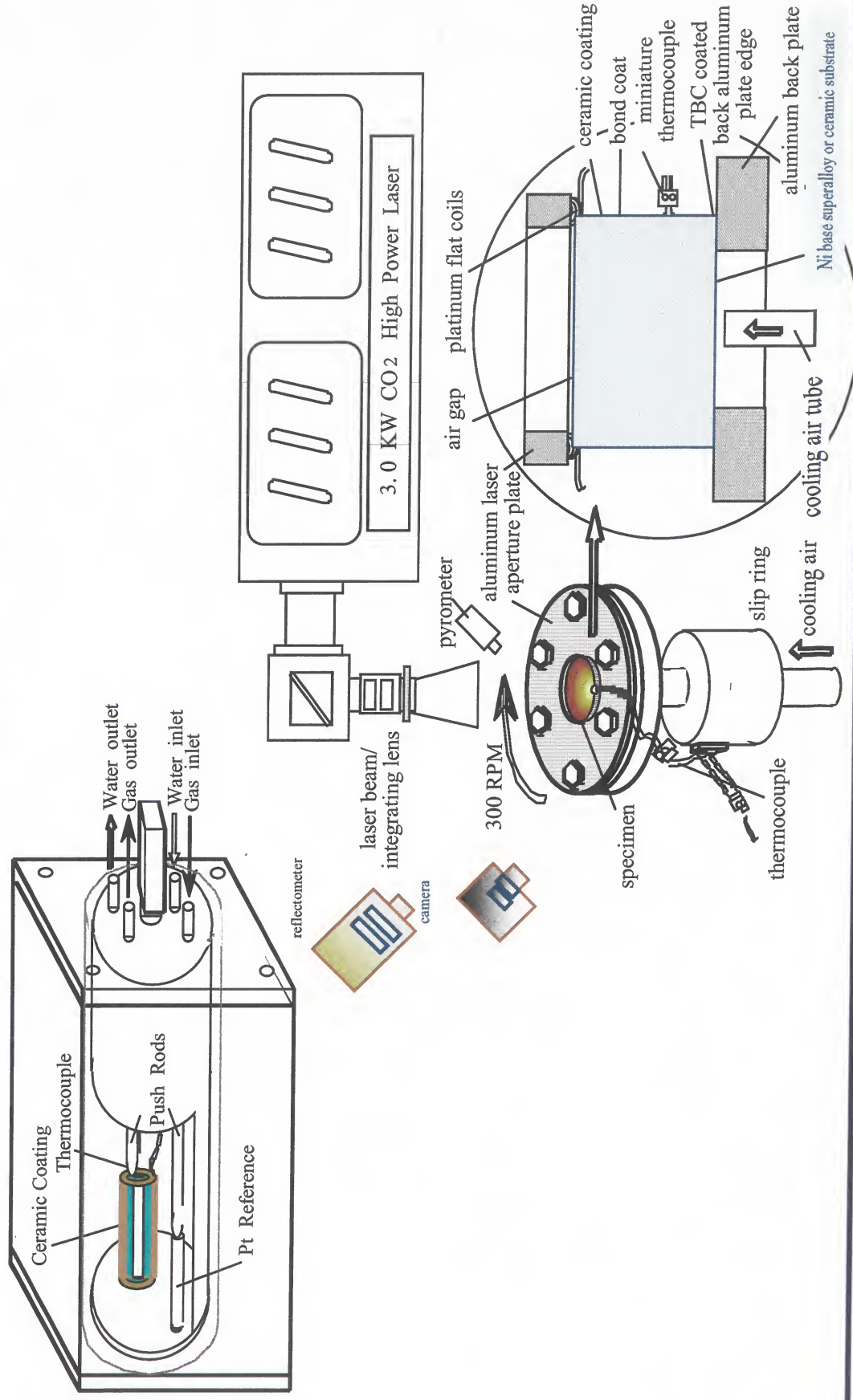
Introduction

- **Environmental barrier coatings (EBCs) are critical to future gas turbine engine systems**
 - Further increase engine operating temperatures, thus helping achieve engine efficiency, emission and performance goals
 - Provide effective thermal and environmental protections for critical engine components (especially light-weight ceramic matrix composite combustors), thus improving engine reliability and durability
- **Rare earth silicates are considered promising candidate materials for environmental barrier coatings applications**
- **Thermophysical properties at high temperatures are needed for coating system design and development**
 - Thermal expansion and thermal conductivity of selected rare earth silicate materials characterized in this study



Thermal Expansion and Laser Heat Flux Thermal Conductivity Test Apparatus

— Dilatometer and laser heat flux rig

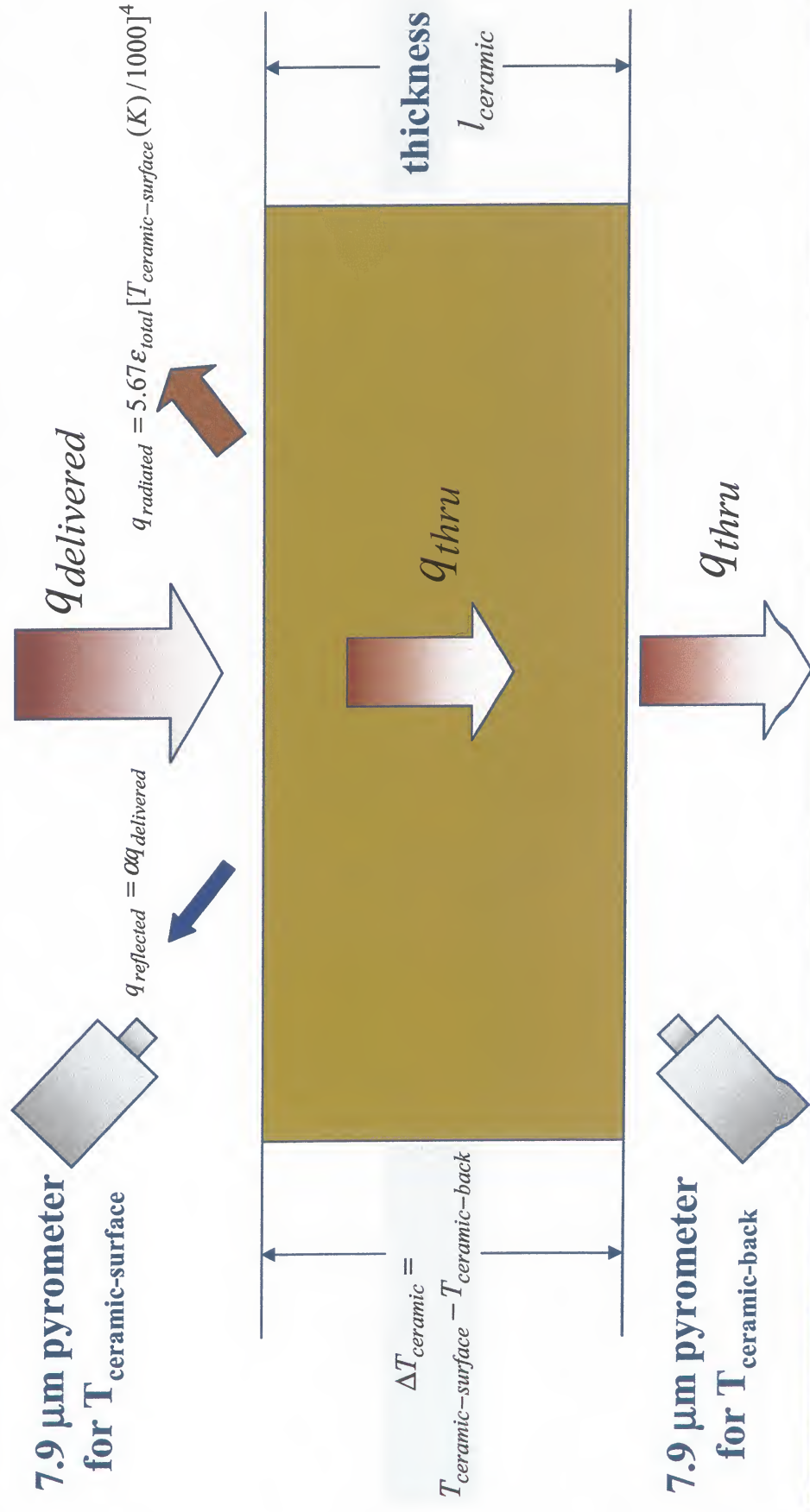




Ceramic Thermal Conductivity Measurements

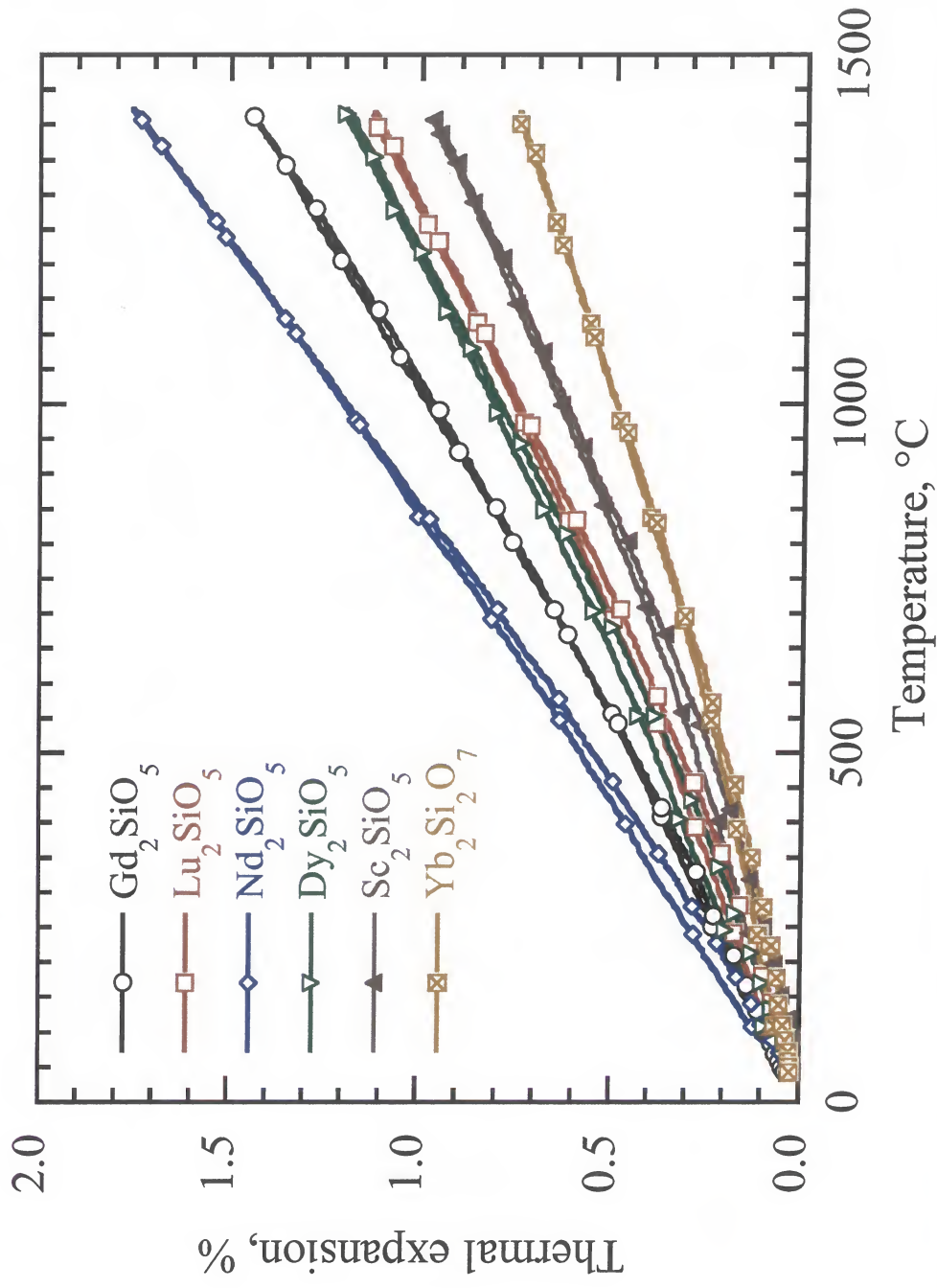
$$k_{\text{ceramic}} = q_{\text{thru}} \cdot l_{\text{ceramic}} / \Delta T_{\text{ceramic}}$$

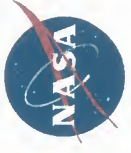
Where $q_{\text{thru}} = q_{\text{delivered}} - q_{\text{reflected}} - q_{\text{radiated}}$



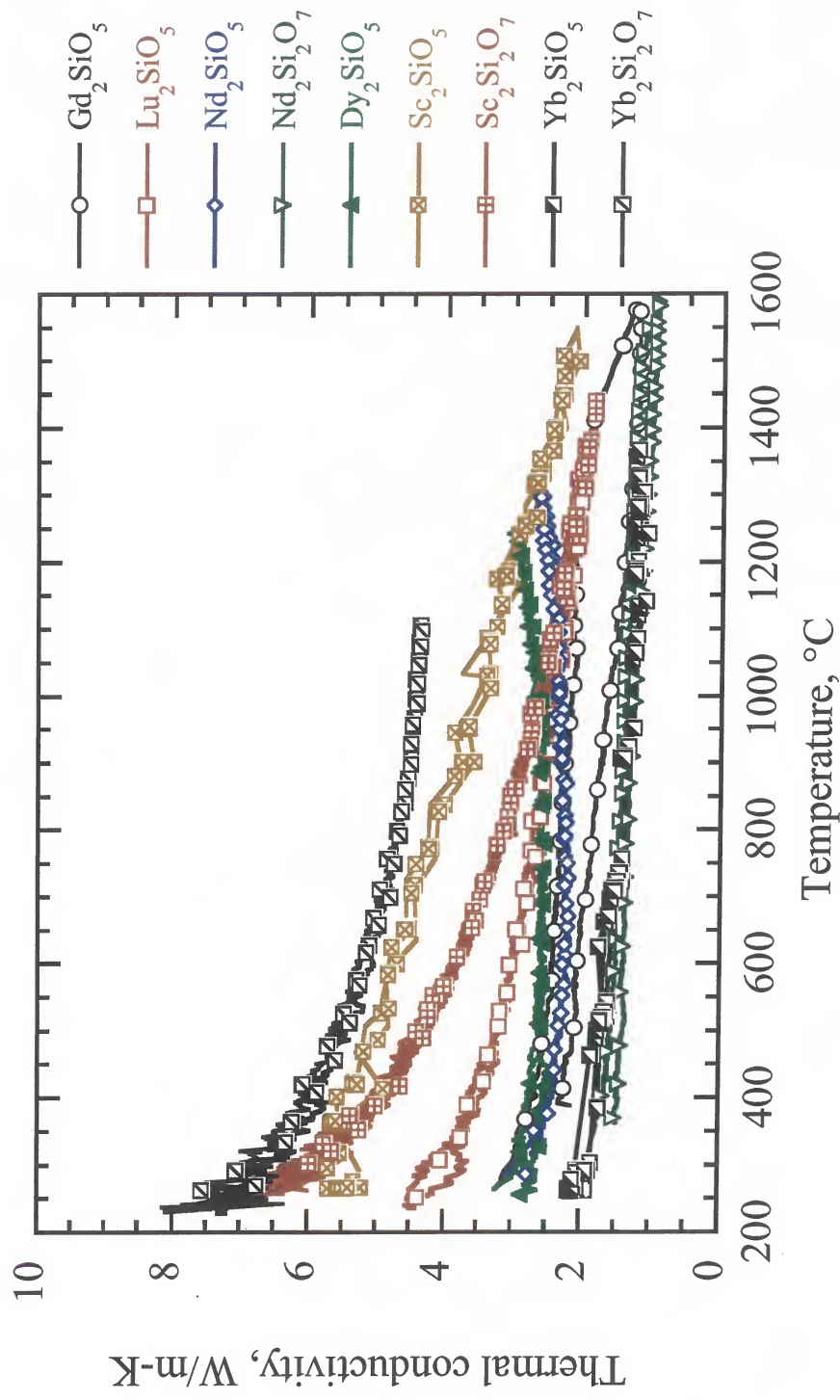


Thermal Expansion of Selected Rare Earth Silicates



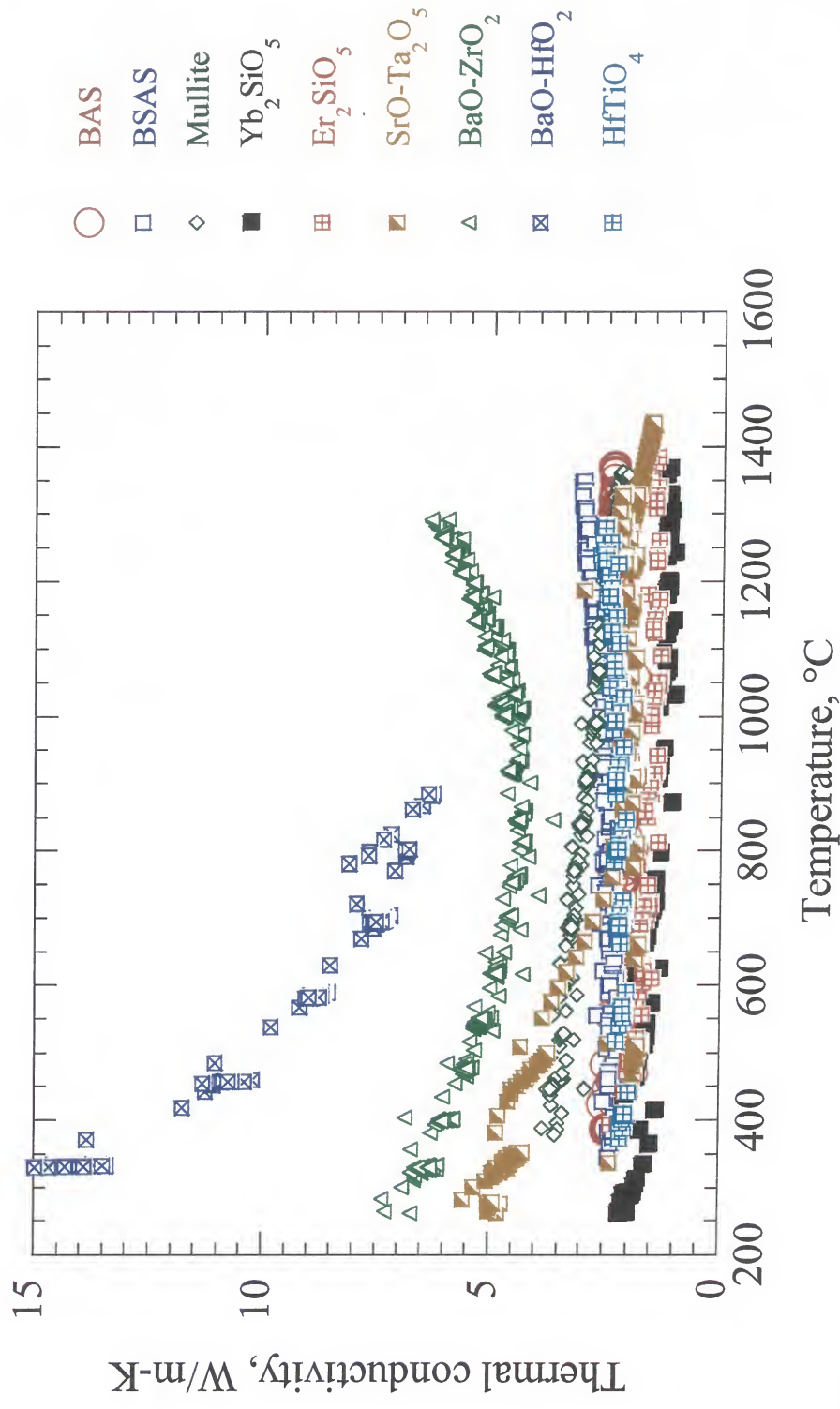


Thermal Conductivity of Selected Rare Earth Silicates





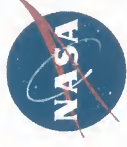
Thermal Conductivity of Candidate EBC Materials Including Rare Earth Silicates





Summary and Conclusions

- Thermal expansion and thermal conductivity of rare earth silicates evaluated at high temperatures
- Rare earth silicates are potential materials for EBCs



Future Work

- **The effects of specimen porosity, composition and microstructure associated with materials processing and testing on the properties being further investigated**
- **Stability of rare earth silicates in combustion environment under thermal cycling being evaluated**